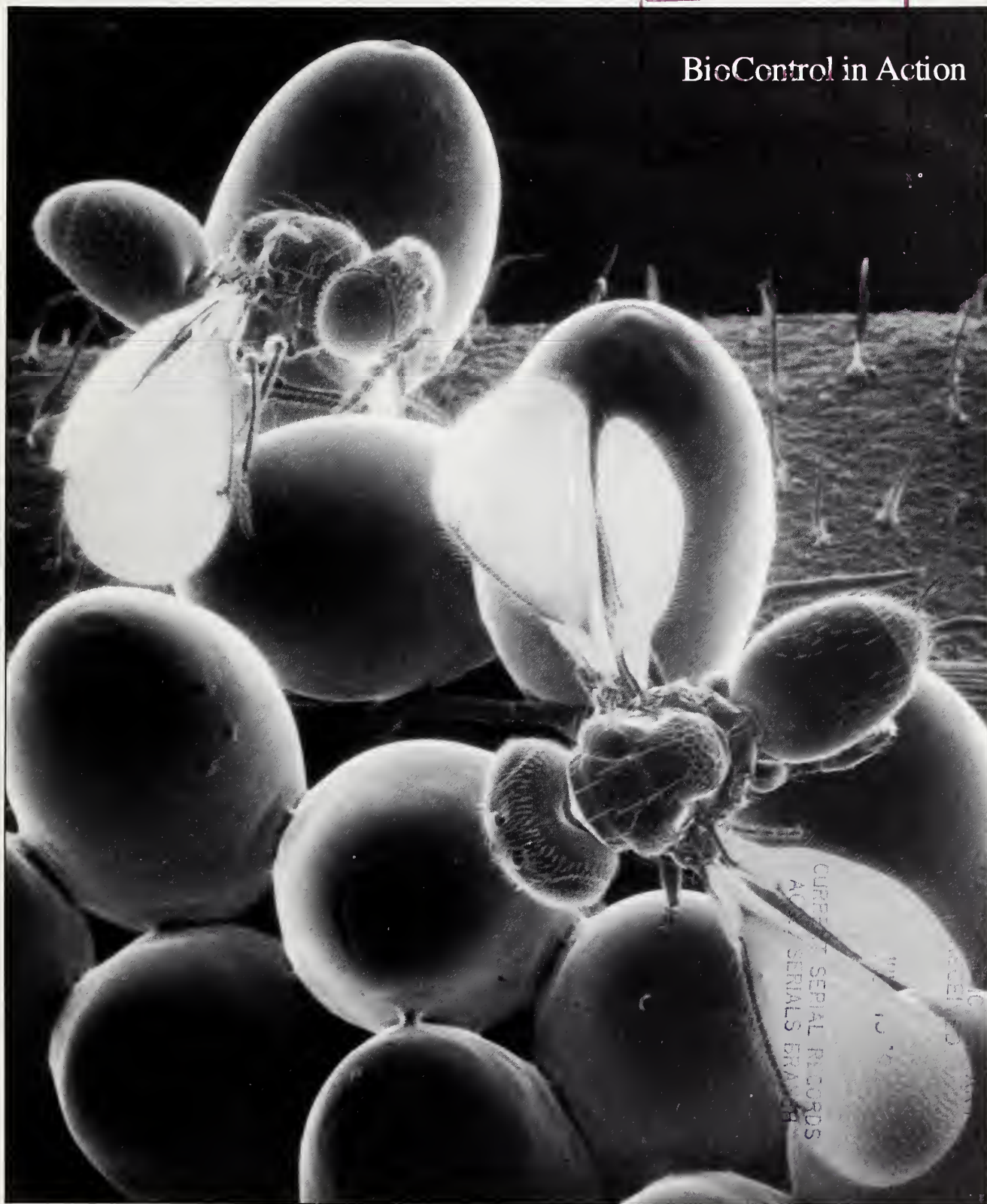


Historic, Archive Document

Do not assume content reflects current
scientific knowledge, policies, or practices.

Agricultural Research

BioControl in Action



Here's to Excellence

As ARS enters the new year, it is appropriate to reflect on those within the agency who have provided the scientific leadership to solve some of the major agricultural problems facing the nation's food and fiber producers.

Four researchers quickly come to mind—recipients in 1984 of the highest honor that ARS can bestow for dedicated and brilliant research. Each is a leader in his field—commanding the respect of the agricultural community.

The ARS Scientist of the Year award went to James H. Tumlinson III, for his research on the chemistry and biology of insect behavior. As a result of his work, pheromones are being used commercially to lure insects into traps and to confuse pests so they fail to mate successfully. Pheromones and pheromone response have been studied in some of this country's most damaging pests, including the boll weevil, Japanese beetle, peachtree borer, and corn rootworm.

Dr. Tumlinson's two decades of pheromone research greatly advanced the science of insect control. His research has provided scientists a basis for further studies aimed at developing a better understanding of how insects perceive odors and respond to them. The understanding of pheromones has also been a major force in the development of alternatives to "all-purpose" insecticides.

Last year, Dr. Tumlinson's research team identified and synthesized the queen-recognition pheromone of the imported red fire ant—the first pheromone of its kind to be chemically identified. Other research of his has helped several industries develop pheromones for use in agriculture and home gardens.

S.M. (John) Mircetich, the western region's Scientist of the Year, was cited for research that led to a better understanding of the causes and development of control measures for several diseases of tree fruit and nut crops. Conservative estimates credit Dr. Mircetich's research with reducing tree crop losses from decline diseases by 30 percent a year. This represents an annual savings to growers of about \$11 million in the western states alone.

Dr. Mircetich discovered that almond leaf scorch—a disease that was threatening California's almond growing industry—was spread from tree to tree by leafhoppers. He showed that the same bacterium that caused leaf scorch was transmittable to grapevines, and he helped devise control measures.

Dr. Mircetich was the first to show that blackline disease in walnuts was an infectious disease caused by cherry leafroll virus. Blackline had plagued English walnut growers for more than 50 years. His identification of the cause of the disease and how it spreads permitted the walnut industry to apply control measures and to

replant infected groves. The industry hailed Dr. Mircetich's discovery as the most important development in walnut production in the last half century.

The eastern region's Scientist of the Year is K. Darwin Murrell. Dr. Murrell has made outstanding contributions to the branch of science known as immunoparasitology, in which scientists approach control of animal parasites by studying their effects on animal immune systems.

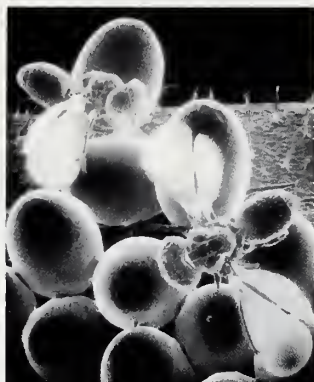
Dr. Murrell recently showed that an animal's immune response to parasitic worms can be linked to certain proteins secreted by the worms. This work may make possible vaccines against worms that cause millions of dollars in livestock losses each year.

Dr. Murrell stresses modern biotechnological approaches in research resulting in key advances for maintenance of the nation's livestock herds. For example, scientists under Dr. Murrell's direction have recently produced a blood test that detects trichinosis in swine. They have also identified chemical "messengers" of white blood cells that help cattle, sheep, and swine resist some parasites.

North central's Scientist of the Year is William L. Ogren. Dr. Ogren is a plant physiologist whose research added to the understanding of photosynthesis and photorespiration. His paramount scientific contribution is a discovery that provided researchers with better knowledge of the plant enzyme, ribulose biphosphate carboxylase/oxygenase. This enzyme helps plants assimilate carbon for the production of sugars they need to live and grow. Dr. Ogren found that the enzyme also plays a key role in the conflicting process of photorespiration in which plants turn sugars back into carbon dioxide. Because of photorespiration, such crops as soybeans, wheat, and alfalfa lose about a fourth of the carbon dioxide they take in from the atmosphere. In Dr. Ogren's recent research, he has provided a rationale and specific selection procedures for reducing photorespiration in these crops to make them more efficient.

These scientists are but four of the many who will keep ARS in the forefront of agricultural research in the years to come.

Terry B. Kinney, Jr.
Administrator



Agricultural Research

COVER: Parasitic female wasps (*Edovum puttleri*) prepare to oviposit in the eggs of the Colorado potato beetle—the top destroyer of U.S. potatoes, tomatoes, and eggplants. In studies at the Beneficial Insect Research Lab, Beltsville, Md., entomologists are rearing thousands of these tiny wasps (less than 1 mm long). Story begins on page 4. (PN-7129) SEM by Norita Chaney, ARS Electron Microscopy Lab, Beltsville, Md.



7

7 Unraveling the Mystery of Wheat Growth Hormones

Secrets to higher yield buried deep within the cells.

8 Biocontrol Takes Off in a Pilotless Miniplane

MADDSAP-1 stands-by for treetop research on biological control.

10 Grains Hold the Key to Reducing Blood Cholesterol

Risk factors associated with heart disease are lowered by oat and barley components.

12 Weevils Cloud Sunflower Scene

Scientists seek protection for world's number two oilseed crop.

DEPARTMENTS

4 AgNotes

Sickle Cell Anemia Cramps Relieved

In This Corner of The Pinhead...

Windstorms Carry Away Plant Cells Too

Guard Dogs Get Good Grades

14 Technology

Underemployed Sugar Can Have Its Own Whey

Making lactulose has confounded scientists since the sugar's discovery over 50 years ago.

Modern Humpty Dumpty Reports on Broken Eggs

Plastic egg rattles on rough handling by equipment.

Staining Machine Improves Detection of Cracked Eggs

The most sharp-eyed human cannot hold a candle to this machine.

16 Patents

Extracting Fats and Oils with CO₂

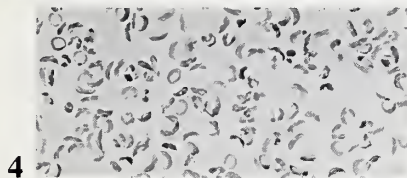
Dripless, No-Waste Applicator for All Herbicides

Biocontrol for Universal Root Pathogens

From Cheesemaking Waste to Commercial Sugar



10



4

Agricultural Research
Vol. 33, No. 1
January 1985

Editor: Lloyd E. McLaughlin
Assistant Editor: Judith L. McBride
Photography Editor: Robert C. Bjork
Assistant Photography Editor: Anita Y. Rogers
Art Director: Deborah Shelton

Reference to commercial products and services is made with the understanding that no discrimination is intended and no endorsement by the Department of Agriculture is implied.

Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through March 31, 1987. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Rm. 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

John R. Block, Secretary
U.S. Department of Agriculture

Orville G. Bentley, Assistant Secretary
Science and Education

Terry B. Kinney, Jr., Administrator
Agricultural Research Service

Sickle Cell Anemia Cramps Relieved

Preliminary studies show for the first time that vitamin B-6 relieves painful body cramps caused by sickle cell anemia, an ARS chemist says.

Sickle cell anemia is an inherited blood disease affecting approximately 50,000 black Americans. Victims suffer debilitating attacks of cramps, especially when under day-to-day stress, and often require hospitalization.

Robert D. Reynolds, a co-researcher in the studies, cautions that vitamin B-6 is not a cure for the disease. Indiscriminate use of high doses of the vitamin may lead to serious nerve damage, he says.

After observing a vitamin B-6 deficiency in all sickle cell anemia patients they studied, Reynolds and Clayton L. Natta, of Columbia University, New York, carried out tests of the vitamin over the past year and a half at Columbia University affiliated hospitals in New York. Natta directed the vitamin dosages and

blood sampling and Reynolds performed the laboratory analyses.

Over 18 months, Natta gave two 50-milligram oral doses of the vitamin daily to five patients with the disease. Sickle cell anemia symptoms, such as cramps, decreased in frequency and severity. All of the patients reported that their general well-being had improved, Natta says.

The researchers cited the case of one patient with a history of being hospitalized by sickle cell anemia attacks about once every 2 months. But, while taking daily B-6 supplements for a year, the patient needed no hospital care.

Reynolds and Natta say they plan to undertake further research immediately on vitamin B-6's role in alleviating attacks of sickle cell anemia.—**Vincent Mazzola**, Beltsville, Md.

Reynolds is located at the USDA-ARS, Vitamin and Mineral Nutrition Laboratory, Beltsville Human Nutrition Research Center, BARC-East, Beltsville, MD 20705. ■

Winterfat—Nutritious Shrub for Reclamation

A perennial shrub that grows naturally throughout the western United States promises to be ideal for reclaiming strip-mined areas and improving rangeland.

Winterfat (*Eurotia lanata*) is the dominant and most conspicuous plant on vast areas of winter range, appearing in patches from several square rods to thousands of acres. But, for the past 40 years, humans and their machines have had hairy problems in trying to plant its seeds.

Two scientists in Cheyenne, Wyo., have found that germination and survival rates are higher if the whole fruit, rather than threshed seed, is used. Typically, the fruit is

threshed to remove the covering of silky, white hairs that clog up conventional seeding equipment. While this makes seeding easier, it damages about 25 percent of the delicate embryos. The most serious effect is that seeds no longer sense gravity, and roots grow in any direction, including straight up.

Range scientists D. Terrance Booth and Gerald E. Schuman are conducting basic studies on winterfat because it is capable of rapid growth in harsh climates. It is also nutritious and palatable and provides important browse for livestock and wild animals.

Recent findings suggest that fruit hairs may be a source of calcium and magnesium for germinating seeds. The hairs also anchor the fruit to soil to keep them from being blown away and hold them in place while the roots push down.

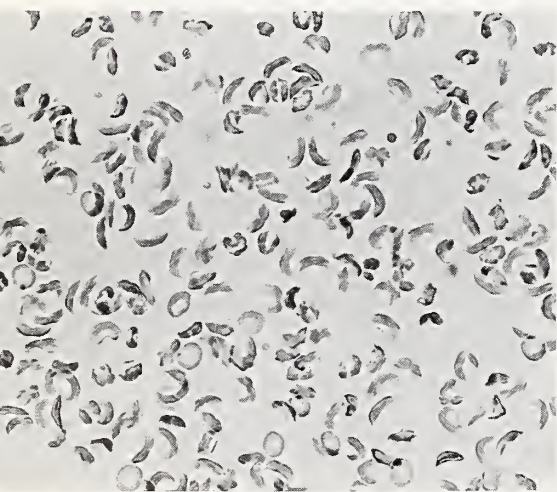
According to Booth, "The best way to seed winterfat is by broadcasting the whole fruit on a rough seedbed just before a cool, rainy season or before spring snowstorms. Seeding into an annual crop residue is also helpful if the fruit makes good contact with the soil."

Current research centers on fluid drilling because the hairs do not clog equipment with this method. Whole fruits are put in a gel and the gel extruded onto the soil. The gel glues fruits to the soil surface, which improves the anchoring function of the hairs.—**Dennis Senft**, Albany, Calif.

D. Terrance Booth and Gerald E. Schuman are located at the High Plains Grasslands Research Station, 8408 Hildreth Rd., Cheyenne, WY 82009. ■

In This Corner of the Pinhead . . .

A wasp, so small it can stand on a pinhead, has been pitted against



Red blood cells from a patient with sickle cell anemia clearly show how the painful disease got its name. The few round, normal-appearing cells may be resistant to the disease. Photomicrograph by William P. Winter, Center for Sickle Cell Disease, Howard University, Washington, D.C. (PN-7140)



Tomato plant destroyed by larvae of the Colorado potato beetle attests to the voracious appetite of these costly pests. (0783X871-27A)

the top destroyer of U.S. potatoes, tomatoes, and eggplants in a 3-year pilot project.

The wasp, a tiny South American immigrant named *Edovum puttleri*, is the most promising natural means yet found to control the Colorado potato beetle, says Agricultural Research Service entomologist Robert F.W. Schroder.

The pilot project will employ an integrated pest management approach, Schroder says, combining a biological agent—like the wasp—with limited amounts of pesticide applied at crucial points in the beetle's life cycle.

Schroder, coordinator of the pilot project, says that the female

wasp is very selective in choosing Colorado potato beetle eggs in which to lay her own eggs. She approaches a beetle egg, taps it with her antenna, and, if it "turns her on," she lays an egg in it. "Fortunately, the wasp liked and parasitized 60 to 80 percent of the beetle eggs in preliminary field trials," Schroder says. "This rate is high enough to give effective control in most cases," he added.

Control of the Colorado potato beetle by conventional chemical means is estimated to cost growers more than \$120 million yearly. And, without control measures, crop losses would approach 100 percent in some areas, Schroder says. Adding to the problem, the pest is developing resistance to all commonly used insecticides, he says.

Joining ARS in the pilot project, scheduled to be completed by December 1987, are the New Jersey Agricultural Experiment Station, the New Jersey Department of Agriculture, and the Virginia Truck and Ornamentals Research Station. If the pilot project is successful, the wasp could be incorporated into pest management programs within 5 to 6 years, Schroder says.

Schroder and Michael M. Athanas, an entomologist at the University of Maryland, reared the wasps needed in earlier tests at Schroder's Beltsville, Md., laboratory. He says that the wasp is rather easy to rear. He figures present costs at about \$10 per 1,000 wasps but expects a decrease when steps are taken to make the process more efficient. Mass-rearing techniques will be made available to other public agencies and commercial biocontrol firms, Schroder says. —Annelle Black, Beltsville, Md.

Robert F.W. Schroder is located in Bldg. 417, Beneficial Insect Introduction Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705. ■

Windstorms Carry Away Plant Cells, Too

A wind tunnel in Manhattan, Kans., is providing new evidence that cells of young plants—as well as the soil—are literally torn away in windstorms that sweep across Great Plains farmland.

Dean V. Armbrust says his wind tunnel tests confirm that wind-blown soil causes the loss of cells and other damage to plants and reduces yields. Sand-laden wind bombarded seedling sorghum, soybeans, and wheat at 30 miles an hour in tests he ran to mimic nature's "sandblasting" of newly emerging plants.

Wheat seedlings proved most vulnerable to wind and sand damage 7 to 14 days after they sprouted from the ground, says Armbrust, an Agricultural Research Service soil scientist. At that age, a wheat plant is about 6 inches tall.

"Wind and sand can combine to whip leaves and tatter their edges. They often end up looking like the frayed-edge flags we sometimes see flapping and snapping overhead," he says.

When exposed to 40 minutes of sandblasting, 2-week-old soybean plants lost 57 percent of their dry weight. Grain sorghum plants lost 43 percent.

After a windstorm, less leaf area is left to capture sunlight and photosynthesize sugars for nourishment, he says, thus forcing plants to divert energy to replace these tissue losses, delaying and reducing growth.

In the wind tunnel on the Kansas State University campus, Armbrust tested plants at 3, 7, 14, 21, and 28 days after emergence from the soil and at exposure times ranging from 10 minutes to 80 minutes.

According to Armbrust, windbreaks of trees or farming practices

that slow windspeed to 15 miles an hour at ground level will protect soil from blowing and new plants from sandblast effects.—**Ray Pierce**, Peoria, Ill.

Dean V. Armbrust is located at Wind Erosion Research, USDA-ARS, Department of Agronomy, Kansas State University, Manhattan, KS 66506. ■

Guard Dogs Get Good Grades

Guard dogs can offer a reasonable first-line of defense against coyotes and other predators of sheep, according to a 7-year



No fraternizing on the job: Wildlife technician Grey Pendleton must remind this young Komondor sheep dog that he is being trained for work and not play. (0779X977-11A)

study by ARS researchers.

Wildlife biologist Jeffrey S. Green and colleagues at the U.S. Sheep Experiment Station, Dubois, Idaho, watched and filmed three breeds of guard dogs—Great Pyrenees, Hungarian Komondor, and Turkish Akbash—in action protecting sheep flocks.

Breeds such as these have been used for centuries in Europe and Asia to protect sheep, but the idea is relatively new in this country. Historically, U.S. ranchers have relied on trapping, snaring, denning, poisoning, and hunting to reduce the number of predators, says Green. However, after a 1972 federal order banned poisons and other control methods proved inadequate, “we started looking at guard dogs as an environmentally acceptable means of protecting individual flocks.”

Clair E. Terrill, former ARS program leader for sheep research, believes predator losses to have been “the primary cause of the decline of the U.S. sheep industry since World War II,” although he admits many disagree with his conclusions. He has made an intensive study of losses of sheep and lambs to predators dating back to 1940 and estimates the cost in lost property and income to sheep ranchers averages over \$100 million annually, or 50 percent of a rancher’s net returns. And predators are not confined to the West, he says; they are on the rise in the Northeast and Midwest.

The Idaho researchers raised 60 pups of the three breeds and placed the dogs on sheep ranches in nine Western and Midwestern states for training. Then they worked with ranchers to study how the guard dogs react on the range to coyotes and other predators such as wild dogs and bears.

Overall, the dogs in the study successfully repelled predators in about two-thirds of the test situa-

tions, Green says. Most of the Great Pyrenees and some of the Turkish Akbash did a good job guarding sheep on both open rangelands and fenced pasture, says Green. Hungarian Komondors worked well only on fenced pasture.

“We have seen some dogs guarding more than 1,000 sheep on 1,000 acres of rangeland or fenced pasture,” Green says. Some ranchers reported that guard dogs are the only method of control used or needed in their operation. “Just the presence of a dog may be enough to deter coyotes or other dogs,” he notes.

“But,” he cautions, “our study showed that guarding ability varies from breed to breed, from dog to dog, and from one situation to another. Guard dogs do not work everywhere for everyone.” Whether a dog is effective depends on its ability and age, the herder’s patience and experience, the acreage and terrain where the sheep graze, the rancher’s management practices, and the number and types of predators in the area.

According to Green, a dog’s success depends on training it to develop a bond to the sheep. To ensure proper socialization of dog to sheep in most situations, he advises prospective dog owners to place a 6- to 8-week-old puppy in with sheep in a confined area; treat a dog as a working animal, not as a pet; and supervise and correct unwanted behavior, such as chasing sheep and playing too rough.

Green says the average first-year expense for owning a dog was \$834. This included purchase, shipping, feed, health care, travel, and miscellaneous expenses. Subsequent expenses for food, health care, and other costs averaged \$286 per year.—**Henry Becker**, Beltsville, Md.

Jeffrey S. Green is located at the U.S. Sheep Experiment Station, Dubois, ID 83423. ■

Unraveling the Mystery of Wheat Growth Hormones



Scanning electromicrograph of a developing wheat head reveals vertebrae-like spikelets branching from its axis. By unlocking the hormonal secrets locked in the tissue of the spikelets, researchers hope to increase the number of spikelets per head, and the number of kernel-producing florets on each spikelet—thus increasing yield. SEM by John Gardner, Brigham Young University, Provo, Ut. (PN-7142)

Large increases in wheat yields occurred during the last few decades as a result of new wheat varieties and the use of fertilizers, pesticides, irrigation, and sophisticated farm machinery. But despite continued research in these areas, a slower rate of increase in wheat yield is expected in the future.

The barriers to increased nutrition and yields lie within wheat cells. But, according to ARS biochemist Edward J. Trione, a basic, new understanding of the role hormones play in the growth and development of wheat and other cereal grains could lead to significant increases in grain production and nutrition.

Hormones are already known to control several important aspects in the development of the wheat plant. Among these are the number of tillers, the number of spikelets per head, and the number of florets that develop within each spikelet.

“Once the flowering and reproductive mechanisms in cereals are unraveled, the implications for increasing yields become fantastic,” says Trione, who is located in Corvallis, Ore.

The secrets of hormone-regulated development, buried deep within the wheat head spikelet, are slowly being revealed to Trione and colleagues, microbiologist Gary M. Banowitz and Oregon State University professor Roy O. Morris, with the aid of sophisticated instruments, chemical separation procedures, and monoclonal antibodies.

“Monoclonal antibodies can help us analyze, identify, and measure minute amounts of specific hormones in plant tissues,” says Trione. (See *Agricultural Research*, Jan. 1984, p. 8.)

Trione is currently using monoclonal antibodies to study the relation of cytokinins—plant growth hormones—to the developing wheat spike. His sensitive instruments are coupled to computers, which synthesize the results of his many analyses into a wheat modeling program. He explains, “These results can later be retrieved from the model and summarized into logical pat-

terns of cause-effect relationships.”

Better understanding of the role hormones play in regulating wheat growth could be useful from several points of view:

- Important biochemical characteristics could be added to the wheat model.

- Wheat breeders could use biochemical clues to select for continued increases in the nutritive quality and yield of grain.

- Natural bioregulators could be applied directly to wheat fields to influence crop development.

- Many high-quality winter cereals could be grown in warmer climates if early flowering requirements could be satisfied by hormone treatments.

- Wheat crops could be grown economically in many areas with a short growing season if early growth and flowering could be induced.

- Where the growing season is long, a delay in flowering could result in increased tiller formation and a greater leaf area before flowering and, thus, greater yields.

- Induced early growth and flowering could result in two crops in areas where the growing season is long.

- Greater yields could also result if flowering could be regulated to coincide with periods of increased soil moisture, particularly in dry-belt farming areas.

“Someday,” says Trione, “we may develop hormones into practical field tools farmers can use to manipulate wheat plants in different climatic regions for the greatest possible yields.”

Fertilizers and pesticides now give farmers some control over the cereal crops, he notes. “How much greater would be the advantages to the farmer if plant hormones were available to increase or decrease crop growth and regulate the time of flower initiation to take advantage of the seasons!”

—Howard Sherman, Albany, Calif.

Edward J. Trione is located at Oregon State University, Cordley Hall, Rm. 2074, Corvallis, Ore. 97331. ■

Biocontrol Takes Off in a Pilotless Miniplane



Above: Radio-controlled drone is maneuvered over a peach tree orchard by James Duckworth from his perch in a hydraulic lift. The drone is releasing diesel smoke on command to check wind drift prior to spraying microbial agents. (0784X1049-12A)

Right: Plant pathologist Tim Gottwald (right) changes spore trap drums after collection flight. Entomologist Louis Tedders steadies the aircraft. (0884X1060-8A)



Their research mission can be stated simply enough: develop environmentally safe biological methods for controlling insect pests and diseases of orchard crops. But carrying out the mission among trees that may grow 70 feet tall poses a major problem. How does one collect samples and dispense biological control agents at such heights economically and without endangering life and limb?

In the spring of 1983, entomologist Louis Tedders and plant pathologist Tim Gottwald hit on the solution—a remotely controlled miniplane. On investigating the notion, the scientists found that remotely piloted drones were being used in many military applications but civilian uses had barely been explored.

Now, a prototype biplane with an 8-foot wingspan skims the treetops at the Southeastern Fruit and Tree Nut Research Laboratory, Byron, Ga., collecting pollen, disease organisms, and insects and dispensing biocontrol agents. It has been dubbed MADDSAP-1 (Microbial Agent Dispensing Drone for Suppression of Agricultural Pests). And a larger 12-foot drone, MADDSAP-2, and two more 8-foot drones are currently being built.

After a year and a half of testing and fine-tuning the prototype to their needs, Gottwald and Tedders say that remotely piloted drones can indeed be practical tools for agricultural research. For example, last summer they used the drone to spray a special isolate of *Bacillus thuringiensis* (Bt) in a pecan orchard and achieved 80 percent control of fall webworms (*Hyphantria*

cunea) and 93 percent control of walnut caterpillars (*Datana integerima*)—two pests of pecan trees. The results were comparable to earlier tests in which they used a commercial airplane to dispense the bacteria, says Tedders.

The drone also expedites gathering the huge amounts of data the scientists need to analyze in developing biological controls, says Gottwald. That is particularly true about data on the ebb and flow of insect and disease-organism populations that cripple orchards. The miniplane is also useful for gathering information on an organism's ecology and life cycle—when it reproduces, its feeding habits, its movements, and when it is most vulnerable to attack by biological agents.

To accomplish each of these tasks, Gottwald and Tedders designed five separate radio-controlled systems that are sent aloft one at a time. Depending upon which one is put on board, the drone's payload can reach 42 pounds.

Two of the systems dispense micro-organisms, such as bacteria, fungus spores, and viruses, that infect only the target insects or weeds. This environmentally safe material can be sprayed over the treetops either in water or oil suspensions or as electrostatically charged dust—all in ultra-low-volume quantities.

Two other systems trap insects, spores, and pollen at various altitudes above an orchard. Already scientists using spore traps have been able to estimate disease-causing fungal spore populations in the air above or adjacent to the test orchards. Gottwald anticipates that someday spore trapping can be used in conjunction with humidity, temperature, and wind information to predict the spread of fungal diseases from orchard to orchard or between fields of specific crops such as tobacco.

The fifth system vaporizes oil and emits it from the engine exhaust as a fine smoke. "We use this system," Gottwald explains, "to observe wind direction so that we can estimate drift during spraying and dusting operations."

The two scientists chose the double-winged biplane for the same reason crop dusters used to like this design. "The plane is stable in flight and can be operated at speeds as low as 30 miles per hour without stalling," explains Tedders. The 7½-foot-long fuselage, which the scientists have modified to accommodate their research equipment, also has a relatively large payload capacity.

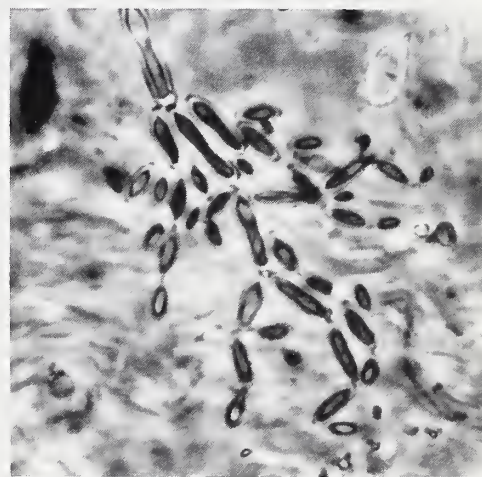
Powered by a 4-horsepower chain-saw engine, the drone can reach speeds approaching 65 miles per hour. It is remotely controlled from the ground by a portable radio transmitter with a ground-to-air range of about 6 miles.

"Contrary to what you might think," says Tedders, "piloting a plane this size from the ground with any precision is more complicated than flying a real airplane."

Several new research systems for the miniplane are in the planning stage. These include a reconnaissance and surveillance system consisting of standard and infrared cameras and a miniature video recorder, equipment to release predacious insects, and a system to release bombs containing biocontrol agents.

At this early stage, the potential of drones has hardly been touched, say the researchers. But in testing its capabilities, they have become convinced of its utility as a research tool. For instance, while testing the insect traps, says Tedders, "we proved what had only been conjectured—pecan aphids migrate. You have to know basic behavioral facts like this about insects before you can devise selective methods to control them."—**Russell Kaniuka**, Beltsville, Md.

Tim R. Gottwald and W. Louis Tedders are located at the Southeastern Fruit and Tree Nut Research Laboratory, P.O. Box 87, Byron, GA 31008. ■



Top: One function of the pilotless miniplane is collecting airborne pollen, disease organisms, and insect pests. In his laboratory, Tedders examines a vial of preserved insects scooped from the air above a pecan orchard. (0884X1050-6). Photomicrograph (above) reveals pecan scab spores, *Cladosporium caryigerum*, trapped from above the same orchard. (0884X1066-3A)

Grains Hold the Key to

Food fabricators may someday add ingredients from barley or oats to decrease the risk of cardiovascular disease. Scientists have isolated and identified substances in these grains that lower cholesterol concentrations in blood plasma of laboratory animals.

The studies by ARS and University of Wisconsin researchers are the first steps in research that could lead to lessening the need for drugs to alleviate diet-related cardiovascular diseases.

"Experimental drugs currently being tested in humans to lower cholesterol are extracted from fungal products. They must be given in large doses, and cause side effects such as nausea and headache," says plant physiologist David M. Peterson, who heads the Cereal Crops Research Laboratory at Madison, Wis. "Laboratory animals that consumed these drugs showed signs of stress on internal organs in addition to lowered cholesterol. But animals that consumed much smaller amounts of two compounds from barley had similarly lowered cholesterol without sign of harmful effect."

The two compounds—a triglyceride and a tocotrienol—were identified by retired ARS chemist Warren C. Burger, former leader of the Madison lab, and two University of Wisconsin researchers—nutrition scientist Charles E. Elson and chemist Asaf A. Qureshi. According to Qureshi, both compounds are found in a high-protein fraction from the aleurone and subaleurone layers of barley. The triglyceride is also found in a bran fraction of oats. Chemically speaking, the triglyceride is 1,3-dilinoleoyl-2-gamma-linolenoylglycerol. The tocotrienol is D-alpha-tocotrienol.

Neither of the cholesterol inhibitors has been tested in humans. However, several species of animals—including chickens, rats, and pigs—have grown fast without getting fat on diets containing them, Peterson says. The inhibitors affect the activity of enzymes that control the rate at which cholesterol is made and broken down into bile acids.

The scientists, with a view of emerging theory about "bad" and "good" forms of cholesterol, measured levels of plasma lipoproteins that are made up of cholesterol linked to proteins. According to the theory, cholesterol that is transported through the bloodstream in the bad form, low-density lipoproteins (LDL), tends to deposit itself on the walls of arteries as plaque, clogging blood flow. The good form, high-density lipoproteins (HDL), may extract cholesterol from artery walls, reducing the risk of cardiovascular disease.

Chickens fed diets containing the inhibitors at concentrations of 25 parts per million (ppm) had a 40-percent reduction in cholesterol-bearing LDL compared with chickens fed a control diet in which corn was the principal ingredient. Concentrations of HDL were similar in chickens fed both diets, says Peterson.

Further studies may provide insights on how enzymes work together to control cholesterol in animals on high-cholesterol diets or why thyroid-deficient or diabetic animals are unable to degrade cholesterol efficiently.

Pioneering research by medical officer James W. Anderson of the Veterans Administration Hospital at Lexington, Ky., showed that diabetic men who consumed about 100 grams of an oat bran fraction daily ceased needing shots of insulin to control their blood glucose. He and coworkers also found a cholesterol-lowering effect of the oat bran fraction in rats and human subjects. He attributes these effects to the high content of water-soluble fiber in oat bran.

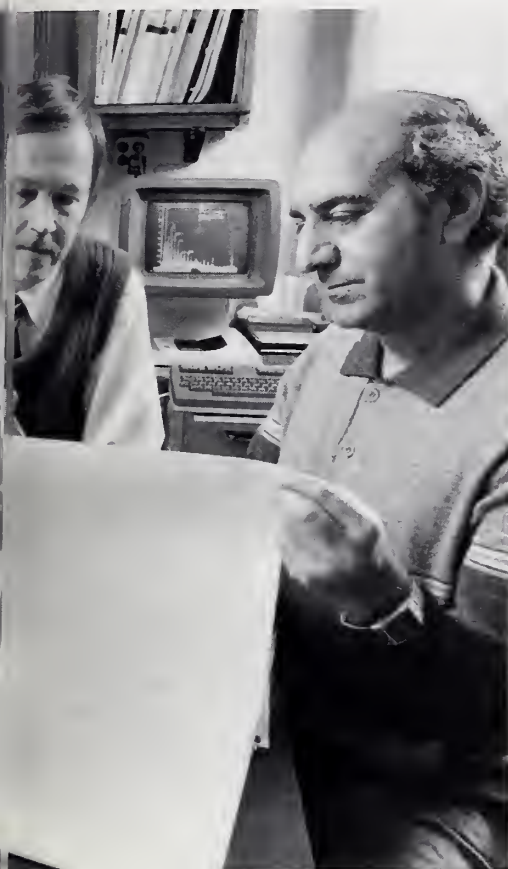


A half-cup of rolled oats in a serving of oatmeal weighs about 30 grams. Consumption of 100 grams daily would require the introduction into the diet of new products such as oat bran muffins, says Peterson. If desirable components could be partially refined from the bran, eating an oat-based dietary supplement might have more popular appeal.

As an outgrowth of Anderson's research, chemist Robert W. Welch, on sabbatical leave from the Welsh Plant Breeding Station, Aberystwyth, Wales, has been working in the ARS laboratory searching for the components of oats responsible for these desirable nutritional phenomena. He is feeding fractions of water-soluble fiber from oat bran to chickens and measuring biological responses.

If scientists identify nutritionally

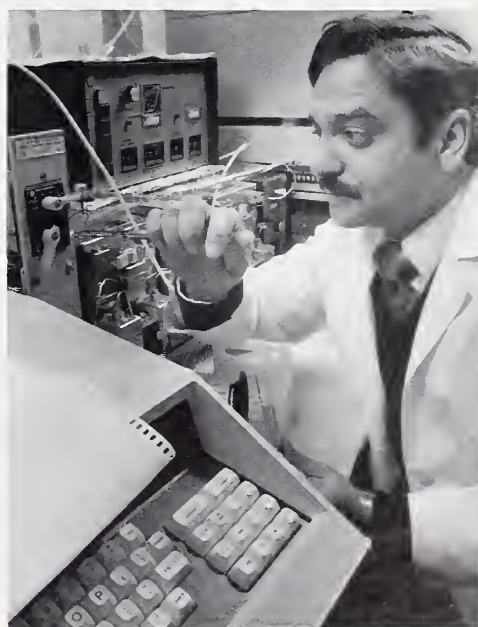
Reducing Blood Cholesterol



desirable oat fractions that can be economically processed, will the market demands of a health-conscious public increase the consumption of oats? A higher demand for milling grade oats used in human food may stimulate farmers' interest in oats production, Peterson says. Presently, only about 7 percent of the oats produced in the United States are consumed by humans.

Barley is used as a food item even less than oats. About half of the barley grown in the United States goes into production of alcoholic beverages, and the other half is used as livestock feed. A significant increase in human consumption of barley components as food would be a major dietary change, Peterson says.—**Ben Hardin**, Peoria, Ill.

David M. Peterson is located at the ARS Cereal Crops Research Laboratory, 501 N. Walnut St., Madison, WI 53705. ■



Above left: Plant physiologist David M. Peterson and University of Wisconsin chemist Asaf A. Qureshi study data from mass spectral analysis of cholesterol inhibitor isolated from high protein barley flour fractions. (1284X1840-21)

Above: Peterson observes chickens fed experimental diets containing oat and barley fractions. (1284X1843-13)

Left: University of Wisconsin specialist Zafeer Din separates active fractions from solvent extract of high protein barley flour by high performance liquid chromatography. (1284X1842-17)

Weevils Cloud Sunflower Scene



Anaphes conotracheli, parasitic wasp of the spotted sunflower stem weevil is approximately ½ mm in length. (PN-7143)

"Finding allies may be the easiest way to win wars," says ARS entomologist Laurence D. Charlet, "especially wars against such insects as the spotted sunflower stem weevil."

Charlet, stationed at Fargo, N. Dak., has found a possible new ally—an egg parasite called *Anaphea conotracheli*. This is the first egg parasite reported for the stem weevil.

Charlet and entomologist Edward U. Balsbaugh, Jr., North Dakota State University, found the parasite in eggs of the stem weevil, *Cylindrocopturus adspersus*. The weevil is a major sunflower pest in North and South Dakota, Minnesota, and the southern high plains of Texas.

First described in 1876 from specimens collected in Texas and California, spotted sunflower stem weevils have been found in most states west of the Mississippi River. The first infestations in commercial sunflower fields occurred in 1973 in southeastern North Dakota and caused yield losses as high as 80 percent in some spots. In 1983, severe weevil damage occurred throughout much of the state.

Sunflowers are one of the few commercial crops native to North America (4.7 million acres in 1982). North Dakota produces more than 70 percent of the U.S. crop. As a cash crop in North Dakota, it is second only to wheat. Sunflowers are second to soybeans as a source of vegetable oil, worldwide.

Although the new egg parasite has only a minor impact on the mortality of the spotted sunflower stem weevil, further research may show that its effectiveness could be improved. Perhaps mass releases early in the season to better synchronize its meeting with the weevil's eggs would help. It normally arrives in mid-July after half the stem weevil eggs are laid, limiting the time it has to work.

The weevil's life cycle begins when adults emerge in mid-to-late June

from overwintering sites in sunflower stalks. They mate and feed on foliage and upper stem tissues. Females travel down the stalk to deposit eggs, one brood per year, individually around the stem and under the surface on the smooth lower portions of new plants.

The larvae develop in the lower stalk, feeding first just under the stem surface and then into the pith within the stem. By the end of August they have fed down to just above the soil surface where they build chambers and overwinter as mature larvae, Charlet says.

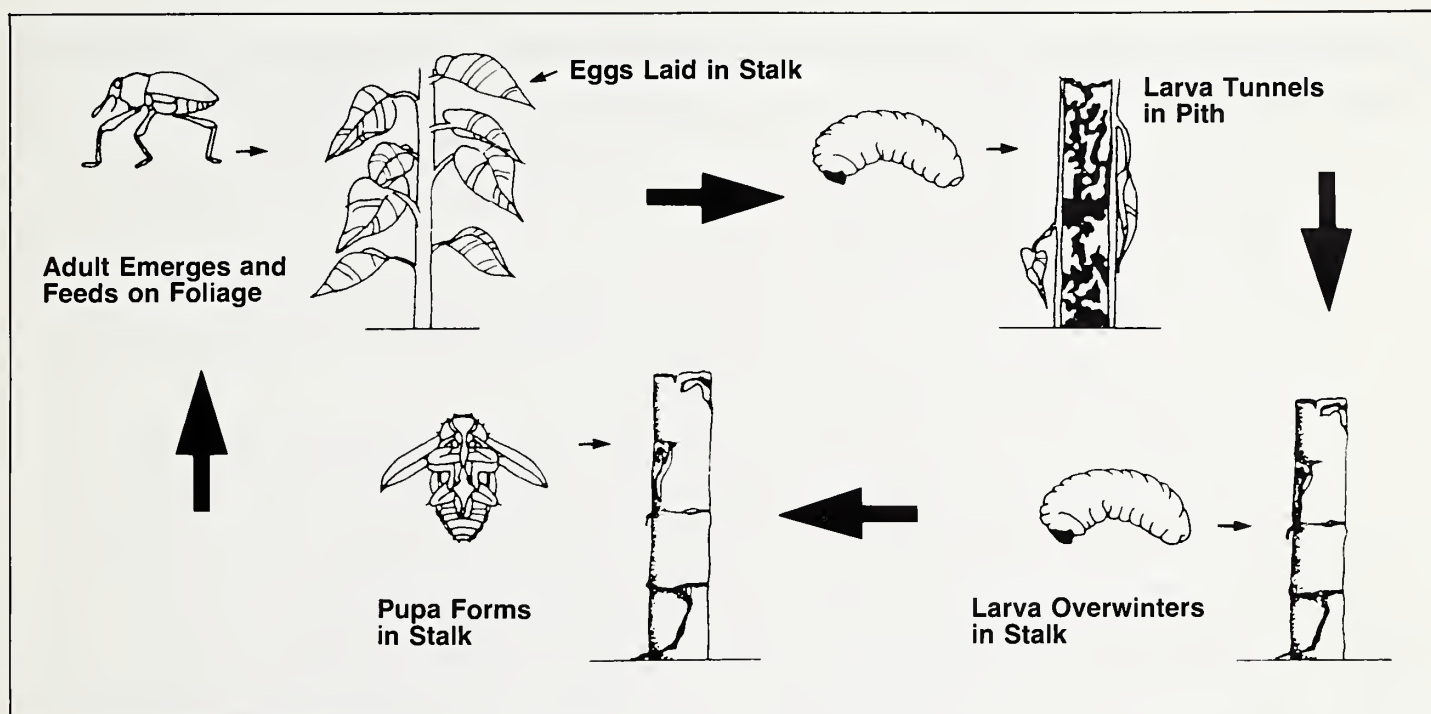
Larvae, feeding through stem tissue, interfere with transport of nutrients. They also weaken the plant as they construct overwintering chambers in the stem wall. When sunflower heads fill with seed, the damaged stalks may fall over under the weight.

"Two or more stem weevils per plant may result in economic losses," Charlet says. Weevils may also transmit fungal diseases such as *Phoma* black stem, which has been isolated from larvae, as well as charcoal rot, which can increase losses.

To evaluate sunflower plants for resistance to the stem weevil, Charlet needed a supply of the insects. To meet this demand, entomologist John P. Reinecke and laboratory technician Sharon R. Grugel succeeded in rearing weevils at the ARS Metabolism and Radiation Research Laboratory at Fargo.

Reinecke and Grugel developed a diet for larval growth, devised a method of sexing pupae and immature adults, and maintained adequate numbers of eggs by using caged host plants for egg laying.

With a reliable source of vigorous specimens available, Charlet and co-workers can study economic injury levels, host-plant attractants, egg-laying stimulants, sex pheromones, and mass-rearing procedures.



Life cycle of the spotted sunflower stem weevil, *Cylindrocopturus adspersus*. (PN-7144)

Developing techniques for rearing insects through their life cycles is a lengthy process, Charlet says, but very important to the study of pest management.

For a number of years, certain areas of sunflower fields have exhibited premature ripening or early senescence. This has been observed in sunflower-growing areas of North and South Dakota and Minnesota, Charlet says. To test whether the spotted stem weevil is a contributing factor, he and ARS plant pathologist Thomas J. Gulya checked 12 North Dakota fields in 1983 and compared prematurely ripened areas in each field with "healthy" areas. Areas showing premature ripening contained twice as many weevil larvae and five times as many broken stalks as other sites.

But Charlet believes that weevils alone do not account for all yield differences in these areas. "Other insects, disease, weather, and genetic makeup of the sunflower plant could all contribute to premature ripening," he says.

Charlet also has studied other pests of sunflower, including the seed weevil, banded sunflower moth, black sunflower stem weevil, and sunflower beetle.

Damage from the sunflower seed weevil, for example, has become severe. And the area of infestation is spreading, Charlet says. Populations of 10 to 12 adults per plant can result in economic loss in seed weight and oil from larval feeding. It is estimated that North Dakota growers lost \$10 million from seed weevil damage in 1982, he says.

The banded sunflower moth is also causing increasing damage to sunflowers in North Dakota and nearby growing areas of Minnesota. It feeds on inner surfaces of the bracts, developing florets and pollen, later tunneling into seeds. As the larvae develop, their color changes from white, yellow, or light pink to red or purple, and finally, at maturity, to green. Larval feeding caused as much as 40 percent seed damage in some 1983 test plots.

The black stem weevil can be found in most sunflower areas of North Dakota. Adult feeders cause little injury, but, like the spotted sunflower stem weevil, it is suspected of transmitting *Phoma* black stem disease.

The sunflower beetle is the predominant defoliating pest in the northern plains. Charlet says that only two beetles per plant can produce as many as 58 larvae, causing a 20 percent yield loss.—**Betty Solomon**, Peoria, Ill.

Laurence D. Charlet and Thomas J. Gulya are located at Oilseeds Research, USDA-ARS, Entomology Department, North Dakota State University, Fargo, ND 58105, Sharon R. Grugel is at the USDA-ARS, Metabolism and Radiation Research Laboratory, P.O. Box 5674, Fargo, ND 58105, and John P. Reinecke is at the Boll Weevil Research Laboratory, P.O. Box 5367, Mississippi State, MS 39762. ■

Underemployed Sugar Can Have Its Own Whey

Lactulose has been one of the more expensive and, thus, underutilized commercial sugars. Now it can be made inexpensively from whey—a byproduct of cheesemaking.

A new production technique, developed by scientists at the Eastern Regional Research Center, Philadelphia, Pa., could make lactulose available for a wide range of food and drug uses, says chemist Kevin Hicks.

As a costly synthetic, lactulose is currently used as a treatment for portal systemic encephalopathy, or hepatic coma. When left unchecked, the disorder can lead to coma and death, says Hicks.

The sugar could also be used as a noncaloric sweetener in specialty foods such as those for low calorie diets, says Hicks. It is about half as sweet as sucrose.

The new technique may have potential use in processing other surplus or abundant sugars for commercial uses, he says. Such sugars are derived from starches and cellulose.

Hicks developed the process with food technologist Phillip Smith and student aide Donna Raupp. They have been granted a patent which is available for commercial licensing. It is Patent No. 4,273,922, "Ketose Sugars From Aldose Sugars." (For information on obtaining a license, see page 16.)

Until now, the detailed chemistry and commercial possibilities for these sugars have not been thoroughly

studied, he says, because they have not been "readily available for

testing." He expects the whey process to create interest among firms in the food and drug industries.

The difficulty of making and purifying lactulose has confounded scientists since the sugar's discovery over 50 years ago.

The situation improved dramatically in 1980 when Hicks and fellow chemists Frederick W. Parrish and Philip E. Pfeffer developed a laboratory-scale process for synthesizing lactulose from pure lactose, a common milk sugar.

Still, lactulose remained expensive, and the new process posed problems. The researchers used boric acid as a reagent, which led to unwanted byproducts and a hard-to-remove methanol residue in the sugar. Moreover, the pure lactose, required as a raw material, added to the cost and complexity, Hicks said.

Hicks, Smith, and Raupp solved these problems in the new process. It involves three steps:

First, cheese whey is "ultrafiltered" to remove valuable proteins. Then, the solution is treated with boric acid and a "reaction catalyst." Finally, to solve the earlier boric acid problem, the solution is passed through three ion-exchange resins.

Hicks says the first resin removes positively charged residues; the second removes uncharged whey components such as riboflavin; and the third removes boric acid and negatively charged ions.

According to Hicks, research indicates that protein removed in the process could be a nutritious supplement for foods from macaroni to ice cream.—**Stephen Berberich and Andrew Walker**, Beltsville, Md.

Kevin Hicks is located at the Food Science Laboratory, Eastern Regional Research Center, 600 E. Mermaid Lane, Philadelphia, PA 19118. ■



Above: In the final step of the new process to obtain lactulose from cheese whey, chemist Kevin Hicks purifies synthetic reaction mixture by passing it through a three-stage ion exchange resin column. (0185X0027-5A)

Left: In the Eastern Regional Research Center's dairy products pilot plant, food technologist Phillip W. Smith monitors "ultrafiltration" which separates protein from lactose fractions of whey. (0185X0028-10A)

Modern Humpty Dumpty Reports on Broken Eggs

They're packed, unpacked, re-packed; stacked, unstacked, restacked; conveyed and trucked; washed, oiled, candled, weighed, sorted. From hen to market, eggs have a long, hard way to go.

By one estimate, about 7 percent do not survive the largely automated journey despite carefully designed equipment and handling procedures. Broken eggs mean lost profit for the egg industry and higher prices for the consumer.

"The trouble is," says agricultural engineer James A. Dickens, "it's hard to pinpoint where breakage occurs because most handling equipment is covered or otherwise out of sight."

To gain insight into the problem, Dickens tested an earlier ARS design for an electronic "egg." (See *Agricultural Research*, Nov. 1970.) The plastic egg-shaped instrument was meant to ride through handling equipment and radio information about the forces being exerted against the shells of real eggs.

Dickens redesigned the egg to work in present-day equipment and conditions. The information radioed by this Humpty Dumpty, he says, along with such information as conveyor speed and elapsed time, would allow operators to locate places where egg breakage is likely to occur.

About the size of an "Extra Large" chicken egg,

Dickens' electronic egg is machined out of clear acrylic rod. Inside the hollow center are a miniature accelerometer—an instrument which converts the energy of impact forces into electric current—and a miniature crystal-controlled, battery-powered radio transmitter.

The signals generated by the accelerometer are broadcast to a receiver wired to a strip-chart recorder. To locate points of possible egg breakage, the operator interprets peaks and valleys printed on the chart during the egg's journey.

Dickens and electronics technician R.E. Vaughn broke 300 real eggs in a pendulum device to calibrate the electronic version. They found that the minimum force required to break eggshells was roughly equivalent to dropping an egg onto a hard surface from a 1/2-inch height.

Dickens and Vaughn tested the egg in an egg-packing plant and in a farm packing operation. Says Dickens, "Even though we were able to carry out only a few tests before the research project ended, we are convinced that the egg will accurately predict where breakage will occur in egg-handling equipment. The egg should assist manufacturers in designing improved equipment."

Entrepreneurs interested in building, testing, and marketing the electronic egg may obtain the plans, specifications, and performance data from Dickens at the Richard B. Russell Agricultural Research Center, P.O. Box 5677, Athens, GA 30613.—**David Pyrah**, New Orleans, La. ■

Staining Machine Improves Detection of Cracked Eggs

Cracked eggs that now escape detection in packing plants will be quickly discovered if they are run through a staining machine designed by agricultural engineer James A. Dickens. "Many hairline cracks are invisible even to the most sharp-eyed candler," Dickens says.

The machine consists of a standard egg conveyor that passes through two spray compartments. In the first compartment, the eggs are sprayed with a stain. In the second, the stain is rinsed off. In between, the stain penetrates any cracks in a shell and dyes the membrane beneath a clearly visible blue.

The stain, developed by microbiologist W.A. Moats at Beltsville, Md., contains iodine, which is also a permitted disinfectant for inshell eggs. "The stain fades rapidly," Dickens says, "and leaves no residue, so cracked eggs that can't be sold in the shell still have value in shelled-egg industries."

Dickens oversaw the candling of 90 dozen eggs to test the usefulness of the machine. "Using standard techniques, experienced candlers found 78 cracked eggs in the lot," he says. "These were removed, and the remaining eggs were passed through the staining machine and recandled. The candlers found 35 more cracked eggs."

In a commercial plant, the machine would be installed in the processing line between the egg washer and the oiler. "Use of this equipment would help packers ship consistently higher quality eggs and also help them meet USDA grade standards more easily," Dickens says. "Also, the risk of shipping eggs that might become microbially contaminated through invisible cracks would be reduced."

Plans, specifications, and technical advice are available from Dickens at the Richard B. Russell Agricultural Research Center, P.O. Box 5677, Athens, GA 30613.—**David Pyrah** ■

PATENTS

PATENTS is a regular feature of *Agricultural Research* magazine. Its purpose is to make the more than 1,200 patented inventions of the U.S. Department of Agriculture better known to businesses and individuals that might benefit from using them.

If you are interested in applying to obtain the license on a patent, write to the following address for an application form and information on license provisions and licensee responsibilities: Patents Office, USDA-ARS, Office of the Administrator, Rm. 323, Bldg. 003, Beltsville Agricultural Research Center-West, Beltsville, MD 20705.

Extracting Fats and Oils With CO₂

Food processors will want to learn more about an efficient new method for extracting fats and oils from oilseeds that has many advantages over the currently used solvent—hexane. The method uses CO₂ heated and compressed above its critical temperature and pressure, which alters its properties.

This supercritical CO₂ is an ideal solvent because it is nontoxic, nonexplosive, cheap, readily available, and easily removed from the extracted products. It is as efficient as hexane at removing triglycerides while yielding a gum-free, light-colored, crude oil with low iron content.

Experimental results under this patent are in direct contrast to previous tenets of supercritical extraction. At a

temperature above 60° C and a pressure in excess of 8,000 pounds per square inch, the lipid solubility increased at least fourfold over previously observed levels.

Under two related patents, the new method yields food-grade corn and soybean products that have an acceptable flavor and extended shelf life. Such higher valued products could help expand world markets for U.S. farm products. The method can also be used to extract fats from animal byproducts such as suet.

For further technical information, contact John P. Friedrich, Northern Regional Research Center, 1815 N. University, Peoria, IL 61604. *Patent No. 4,466,923, "Supercritical CO₂ Extraction of Lipids from Lipid-Containing Materials,"* and the related *Patent Application Serial No. 436,541, "Production of Food-Grade Corn Germ Product by Supercritical Fluid Extraction,"* and *Patent Application Serial No. 534,015, "Production of Defatted Soybean Products by Supercritical Fluid Extraction."* ■

Biocontrol for Universal Root Pathogens

Nearly all cultivated soil in the world contains at least one species of *Pythium*—a serious root pathogen that causes significant reduction in yields of wheat, barley, and other small grains. Some areas, including wheat acreage in the Pacific Northwest, contain 10 or more *Pythium* species. Currently, the only sure way to control this pathogen

complex is soil fumigation, which is prohibitively expensive for commercial use.

Now, a method for selecting soil bacteria that will suppress *Pythium* root rot has been discovered. And four novel strains of fluorescent *Pseudomonas* bacteria have been found to effectively suppress the pathogen in wheat when used as a seed or furrow treatment. These are the first bacteria known to control *Pythium* species on small grain crops.

This patent should be of interest to pesticide companies in general, and of particular interest to those engaged in producing biological control products. Biological seed treatment for controlling root-disease organisms is becoming a technical reality, and the market for such technology is worldwide.

For further technical information, contact David M. Weller, ARS Root Disease and Biological Control Research, 367 Johnson Hall, Washington State University, Pullman, WA 99164. *Patent Application Serial No. 650,739, "Method for Screening Bacteria and Application Thereof for Field Control of Pythium Spp. on Small Grain Crops."* ■

From Cheesemaking Waste to Commercial Sugar

See "Underemployed Sugar Can Have Its Own Whey," p. 14, for information on *Patent No. 4,273,922, "Ketose Sugars from Aldose Sugars."* ■